PRESENTATION 2.3

N91-17031

PAYLOAD ACCOMMODATIONS

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMMODATIONS
AVIONICS PAYLOAD SUPPORT ARCHITECTURE

TECHNOLOGY ISSUES/TRADE STUDIES

DEGREE OF NASA/USER SEPARATION
- MISSION SUCCESS/SAFETY/COMPUTER SECURITY
- CONTROL OF RESOURCES (PWR, COOLING, ETC.)
- STANDARDIZATION OF INTERFACES (D&C, GUIDELINES)
- COMMON SERVICES (NASA, CENTRALIZED) VERSUS UNIQUE SERVICES (USER, DISTRIBUTED)

RELIABILITY/REDUNDANCY RELATIVE TO MISSION SUCCESS/SAFETY

NSTS: CAPABILITY TO PROVIDE U/L, D/L SERVICES TO PAYLOADS USING PGSC (MODEM, I/F TO STS COMM SYSTEM)
- CONNECTOR/CABLING VOLUME AND WEIGHT

SSF: INTEGRATION OF EXISTING AVIONICS TECHNOLOGIES TO CONTROL MULTIPLE REAL-TIME SYSTEMS.
- COST/POWER REDUCTION TO MEET BUDGETARY CONSTRAINTS.

LUNAR MARS:
- AUTOMATION/EXPERT SYSTEMS CAPABILITY
- DATA STORAGE CAPABILITY
- DEGREE OF PRETRANSMISSION PROCESSING-CUSTOMER CONCERN

CANDIDATE PROGRAMS

- NSTS ORBITER ENHANCEMENT
- SSF
- SHUTTLE-C
- LUNAR/MARS PROGRAMS
- SHUTTLE-II

MAJOR ACCOMPLISHMENTS:

- APPROACHING CONCEPT IN STS FOR SECONDARY PAYLOADS AND TSS BY UTILIZATION OF PGSC
- DISTRIBUTED PROCESSING CONCEPT BEING IMPLEMENTED IN THE STS JSC MULTIPURPOSE CONTROL CENTER (MPCC)
- ORIGINAL SSF AVIONICS DESIGN FOR PAYLOAD ACCOMMODATIONS CAPTURES MOST OBJECTIVES:
  - DISTRIBUTED PROCESSING ARCHITECTURE
  - DECOUPLE VEHICLE AND PAYLOAD SERVICES
  - STANDARDIZED TESTING, CHECKOUT, AND TRAINING
  - WITH SSF BUDGET/POWER CUTS, SOME OF THESE WILL BE COMPROMISED AT PMC BUT SYSTEM WILL BE UPGRADABLE AND WILL BE IMPROVED WITH THE FULL-UP CONFIGURATION

SIGNIFICANT MILESTONES

- DEFINITION OF THE CANDIDATE CLASSES OF PAYLOADS FOR EACH PROGRAM.
- ASSESSMENT OF PAYLOAD SERVICES FOR EACH PROGRAM RELATIVE TO COST, NEW TECHNOLOGY, RESPONSIBILITY.
- DEVELOPMENT OF PAYLOAD SUPPORT POLICY TO DISTRIBUTE RESPONSIBILITY TO THE USER WHEN PRACTICAL AND COST EFFECTIVE.
- DESIGN AVIONICS PAYLOAD SUPPORT ARCHITECTURE TO SUPPORT THE ABOVE, USING INDUSTRY STANDARDS AND WITH THE CAPABILITY FOR UPGRADES.
- PRODUCE GUIDELINES FOR USERS FOR SUCH ITEMS AS DISPLAY STANDARDIZATION TO REDUCE CREW TRAINING AND OPERATIONS.
- INCREASE IN OPS EFFICIENCY BY THE DEVELOPMENT AND APPLICATION OF NEW AVIONICS TECHNOLOGY INCLUDING AUTOMATION, ROBOTICS, EXPERT SYSTEM, VOICE RECOGNITION, SPEAKER INDEPENDENT SYSTEMS, ENHANCED VIDEO DISPLAY CAPABILITY

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMMODATION
SATELLITE SERVICING

NOVEMBER 1989

ADVANCED AVIONICS CONCEPTS

SYSTEMS INTEGRATION
- SYS. RQMTS DEF.
- TRAJECTORY CTL RQMTS
- SCENARIO ASSM'T
- PROGRAM PLANNING

GN&C DEVELOPMENT
- RELATIVE GUIDANCE
- AUTO PROX OPS
- COOP. CONTROL
- AI APPLI-CATIONS

SENSORS & MECHANISMS
- REL. NAV. SENSORS
- SENSOR TRADES
- MECHANISMS APPLICATION

MAJOR OBJECTIVES:

O DEVELOP AUTONOMOUS RENDEZVOUS, PROXIMITY OPS, & DOCKING/BERTHING CAPABILITIES FOR SATELLITE SERVICING:

- COST EFFICIENCY
- RELIABILITY
- INCREASED AVAILABILITY
- REDUCED CREW WORKLOAD

KEY CONTACTS:

S. LAMKIN/JSC
T. BRYANT/MSFC
R. SAVELY/JSC
R. LEE/TRW-HOUSTON
C. GOTT/JSC

FACILITIES:

O 6 AND 12 DOF ENGINEERING SIMULATIONS (JSC & CSDL)
O MSFC FLAT-FLOOR FACILITY
O THERMAL/VACUUM FACILITIES (JSC & MSFC)

MAJOR MILESTONES (1990 - 1995):

- DEFINE AR&D SYSTEM REQUIREMENTS (1991)
- DEVELOP SENSOR BREADBOARD (1991)
- DEVELOP VALIDATED GN&C SW (1992)
- DEVELOP PRELIMINARY DOCKING MECHANISM (1992)
- GROUND DEMONSTRATION (LATE-1992)
- FLIGHT DEMONSTRATION PLANS (1993)
- SSS AR&D DEMONSTRATION FLIGHTS
  - o DF-1: LATE 1993
  - o DF-3: 1995

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMMODATION
SATELLITE SERVICING

NOVEMBER 1989

TECHNOLOGY ISSUES:

- DEVELOPMENT OF ACCURATE RELATIVE NAVIGATION SENSORS
- DEVELOPMENT AND INTEGRATION OF GN&C TECHNIQUES (INCLUDING AI)
- SYSTEM INTEGRATION OF SENSORS, GN&C SYSTEM & DOCKING/BERTHING MECHANISM

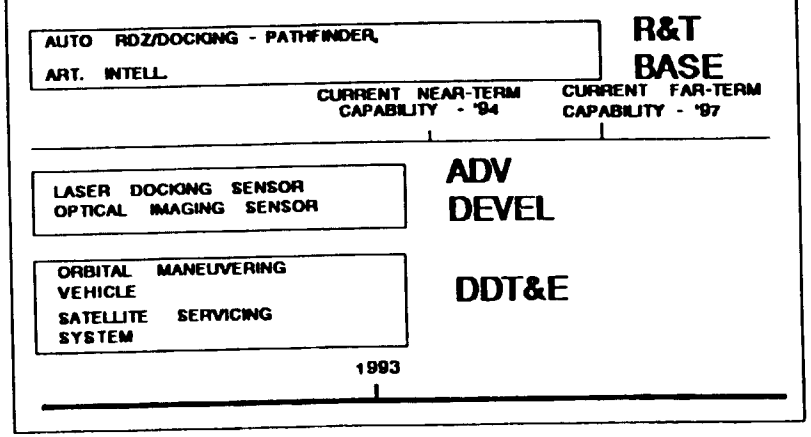
CANDIDATE PROGRAMS:

- SATELLITE SERVICER PROGRAM
- SPACE STATION
- NEXT MANNED TRANSPORTATION SYSTEM
- ASSURED SHUTTLE AVAILABILITY

MAJOR ACCOMPLISHMENTS:

- LASER DOCKING SENSOR CURRENTLY UNDER DEVELOPMENT. RELATIVE NAV CAPABILITY TO SUPPORT SSS
- AR&D PROJECT PLAN FOR PROJECT PATHFINDER HAS BEEN DEVELOPED
- SATELLITE SERVICER SYSTEM PHASE B CONTRACT IS IMMINENT
- AUTONOMOUS OPERATIONS TEST BED DEVELOPMENT (JAN 90)

SIGNIFICANT MILESTONES:



PAYLOAD ACCOMMODATION - SATELLITE SERVICING

MAJOR OBJECTIVES

- DEVELOP AND DEMONSTRATE AUTONOMOUS RENDEZVOUS, PROXIMITY OPERATIONS, AND DOCKING/BERTHING CAPABILITIES TO SUPPORT SATELLITE SERVICING

- DRIVERS FOR AUTONOMOUS RENDEZVOUS AND DOCKING
  - INCREASED RELIANCE ON UNMANNED VEHICLES
  - POTENTIAL FOR HIGHER FREQUENCY MANNED RENDEZVOUS AND DOCKING OPERATIONS

- EXPECTED BENEFITS FROM AUTONOMOUS RENDEZVOUS AND DOCKING
  - INCREASED AVAILABILITY (REDUCED OPERATIONAL CONSTRAINTS)
  - INCREASED COST EFFICIENCY (PROPELLANT, WORKLOADS)
  - MORE CONSISTENCY

PAYLOAD ACCOMMODATION - SATELLITE SERVICING

TECHNOLOGY ISSUES

- DEVELOPMENT OF RELATIVE NAVIGATION SENSORS
  - HIGH ACCURACY
  - EXTENDED OPERATING RANGE
  - LOW WEIGHT, SMALL SIZE AND LOW POWER REQUIREMENTS

- DEVELOPMENT AND INTEGRATION OF GUIDANCE, NAVIGATION AND CONTROL (GN&C) ALGORITHMS/TECHNIQUES
  - ROBUST, RELIABLE, AND ADAPTABLE
  - SAFE (CREW AND VEHICLE)
  - ACCOMMODATE CONTINGENCIES

- INTEGRATION OF SENSORS, EFFECTORS, GN&C ALGORITHMS & TECHNIQUES, AND DOCKING BERTHING MECHANISMS INTO TOTAL SYSTEM CAPABILITY

PAYLOAD ACCOMMODATION - SATELLITE SERVICING

TECHNOLOGY DEVELOPMENT APPROACH

- USE WORK BREAKDOWN STRUCTURE PATTERNED AFTER AR&D PROJECT FOR PATHFINDER (NEXT PAGE)

- PROPOSE TO ALIGN AR&D DEVELOPMENT WITH SATELLITE SERVICER SYSTEM FLIGHT DEMONSTRATIONS

  - ORBITAL MANEUVERING VEHICLE (CHASER VEHICLE)
  - SENSOR OPTIONS
  - STAGED FLIGHT DEMONSTRATIONS OF AR&D CAPABILITIES

PAYLOAD ACCOMMODATIONS - SATELLITE SERVICING

AR&D WORK BREAKDOWN STRUCTURE

SYSTEMS INTEGRATION

- SYS. RQMTS DEF.
- TRAJECTORY CTL RQMTS
- SCENARIO ASSM'T
- PROGRAM PLANNING

GN&C DEVELOPMENT

- RELATIVE GUIDANCE
- AUTO PROX OPS
- COOP. CONTROL
- AI APPLI-CATIONS

SENSORS & MECHANISMS

- REL NAV. SENSORS
- SENSOR TRADES
- MECHANISMS APPLICATION

PAYLOAD ACCOMMODATION - SATELLITE SERVICING

MAJOR MILESTONES (1990 - 1995)

- DEFINE AR&D SYSTEM REQUIREMENTS - 1991
- DEVELOP SENSOR BREADBOARD - 1991
- DEVELOP VALIDATED GN&C SOFTWARE - 1992
- DEVELOP PRELIMINARY DOCKING MECHANISM - 1992
- IMPLEMENT GROUND DEMONSTRATION - LATE-1992
- DEVELOPMENT FLIGHT DEMONSTRATION PLANS - 1993
- SATELLITE SERVICER SYSTEM (SSS) AR&D DEMONSTRATION FLIGHTS
  - DF-1: LATE 1993
  - DF-3: 1995

PAYLOAD ACCOMMODATION - SATELLITE SERVICING

CANDIDATE PROGRAMS

- NEAR-TERM FOCUS ON SATELLITE SERVICER SYSTEM FLIGHT DEMONSTRATION
- SPACE STATION
- SHUTTLE EVOLUTION
- NEXT MANNED TRANSPORTATION SYSTEM
- ASSURED SHUTTLE AVAILABILITY
- LUNAR AND MARS INITIATIVE

PAYLOAD ACCOMMODATION - SATELLITE SERVICING

MAJOR ACCOMPLISHMENTS

- LASER DOCKING SENSOR CURRENTLY UNDER DEVELOPMENT (JSC LEAD)
- OPTICAL SENSOR CURRENTLY UNDER DEVELOPMENT (MSFC LEAD)
- AR&D PROJECT PLAN FOR PATHFINDER PROJECT HAS BEEN DEVELOPED
  - MISSION SCENARIOS DEVELOPED
  - PRELIMINARY SYSTEM REQUIREMENTS DEVELOPED
  - GN&C ALGORITHMS UNDER DEVELOPMENT
  - SENSOR TRADE STUDY UNDER WAY
  - TRAJECTORY DESIGNS UNDER WAY
  - MECHANISMS BASIC RESEARCH UNDER WAY
- SATELLITE SERVICER SYSTEM PHASE B CONTRACT RFP RELEASE IS IMMINENT
- OMV DEVELOPMENT IS IN PROGRESS
- DOCKING/GRAPPLE MECHANISMS FOR SATELLITE SERVICING ARE UNDER DEVELOPMENT

PAYLOAD ACCOMMODATION - SATELLITE SERVICING FACILITIES

- 6 AND 12 DEGREE-OF-FREEDOM ENGINEERING SIMULATIONS (JSC & CSDL)
- FLAT-FLOOR FACILITIES (MSFC AND JSC)
- THERMAL/VACUUM FACILITIES (JSC AND MSFC)
- DOCKING MECHANISM TEST FACILITIES (MSFC AND JSC)

PAYLOAD ACCOMMODATION - SATELLITE SERVICING

KEY CONTACTS

JSC:

STEVE LAMKIN, PATHFINDER AR&D PROJECT MANAGER - 483-8264

CHARLES GOTT, TRAJECTORY CONTROL ANALYSIS - 483-8107

ROBERT SAVELY, ARTIFICIAL INTELLIGENCE DEVELOPMENT - 483-8105

MSFC:

THOMAS BRYANT, AUTONOMOUS RENDEZVOUS AND DOCKING DEVELOPMENT - 544-0617

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMMODATION
SATELLITE SERVICING

November 1989

Advanced Avionics Concepts

- Integrated Test Facility
  - Large Precision Flat Floor
  - Dynamic Overhead Simulator
  - Full-scale Black-out
  - Solar Illumination Simulation
  - Networked Computer Facility

Major Objectives

- Full Scale Mechanisms & Sensors
- Video, Laser, Inertial Sensor
- Dynamic Docking Approach (150')
- Multi-body Simulation
- Large Scale Manipulator Simulator
- FTS - OMV Servicer Simulation

Key Contacts

- E.C. Smith - MSFC
- Tom Bryan - MSFC

Facilities

- MSFC Flight Robotics Laboratory

Major Milestones (1990 - 1995)

• OMV Auto Dock Sensor Evaluation	Jan 1990
• Facility Extension Completion	Feb 1990
• Tumbling Satellite Retriever	Apr 1990
• Dynamic Solar Lighting Simulator	Sept 1990
• Station Module Auto Berthing Demo	1991

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMMODATION
SATELLITE SERVICING

November 1989

Technology Application Issues

- Lighting And Illumination Effects
- Guidance Sensor Realtime Performance
- Mechanism Operations

Candidate Programs

- OMV
- Space Station Berthing Mechanisms
- Flight Telerobotic Servicer
- Stabilized Payload Deployment Mechanism
- Shuttle-C Deployment
- Pathfinder Auto Guidance Development
- Lunar / Mars Vehicle Assembly

Major Accomplishments

- OMV Latch Contact Dynamics
- OMV Auto Dock Demonstration
- GE Polar Platform Auto Dock Sensor
- OMV Video Verification Tests

Significant Milestones

- Facility Extension Completion
- Dynamic Solar Lighting Simulator
- Flight Hardware Dynamic Testing Validation

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMMODATION
SATELLITE SERVICING

ADVANCED AVIONICS CONCEPTS

MAJOR OBJECTIVES:

- Low cost
- Low complexity
- Requires only a passive target
- Capable of operating in a variety of scenarios

KEY CONTACTS

E.C. Smith/MSFC

F. Dabney/MSFC

R. Howard/MSFC

S. Lamkin/JSC

FACILITIES

MSFC Flight Robotics Laboratory

MAJOR MILESTONES (1990-1995):

- Test current technology (1990)
- Complete development of advanced applications (1991)
- Analysis and large scale hardware demonstration (1991)

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMMODATION
SATELLITE SERVICING

TECHNOLOGY ISSUES:

- Sensor range: moving parts vs. reliability
- Self-monitoring system to defect malfunctions

CANDIDATE PROGRAM:

- OMV
- Shuttle C
- Space Station
- MARS Rover-Sample Return
- Satellite Servicing

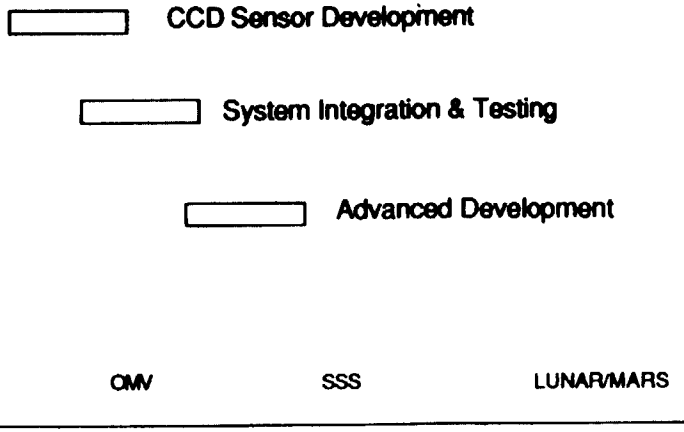
MAJOR ACCOMPLISHMENTS:

Software simulations of various docking/Berthing algorithms

Integrated large-scale hardware tests of system

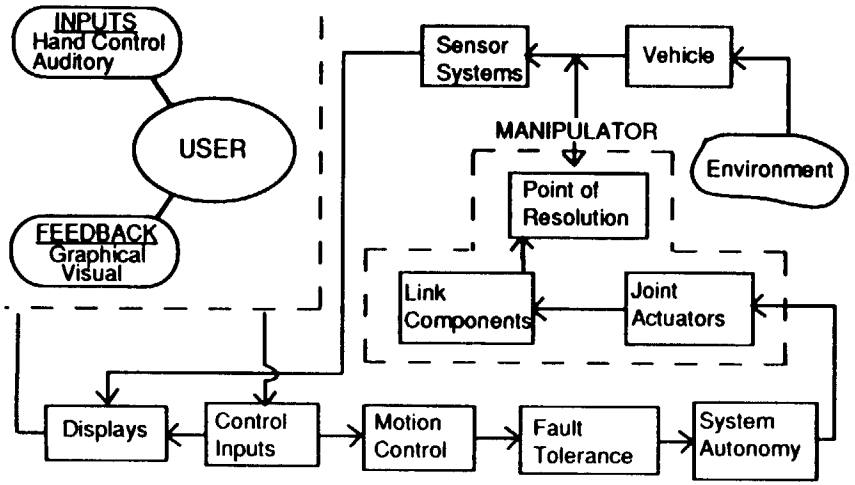
Advanced algorithms developed and awaiting hardware testing

SIGNIFICANT MILESTONES:



SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMMODATION
P/L DEPLOY SYSTEMS & ADV. MANIPULATORS

P/L DEPLOYMENT SYSTEMS & ADV MANIPULATORS



MAJOR OBJECTIVES:

* Reduce pre-mission planning
  - Improved redundancy / fault tolerance
  - Optimal path planning
* Increase crew productivity
  - Autonomous operations frees crew for other tasks
  - Path planning / collision avoidance reduces training requirements and on-orbit planning
  - Dexterous handling reduces EVA requirements
* Increase hardware longevity
  - Load sensing / relief reduces joint / structural loads
* Reduce base vehicle attitude control system sensitivity to manipulator operations

KEY CONTACTS:

C. Gott /JSC/ FM8

D. Homan / JSC / FM8

E. Bains / JSC / EH23

J. Davidson / MMC

FACILITIES:

* Integrated Graphics and Operations Analysis Laboratory (IGOAL)
* Draper Remote Manipulator System Simulation (DRS)

MAJOR MILESTONES (1990 - 1995)

* Major programs to support
  - NSTS
  - Space Station Freedom
  - Lunar Base / Mars Mission Scenarios
* Programmatic Issues
  - Manipulator design and operations requirements
  - Integrate vehicle / manipulator control system design
  - Vehicle assembly and on-orbit processing
  - Lunar base construction
  - Mars surface operations
* Simulation development for state-of-the-art hardware & software
  - Kinematic
  - Dynamic
* Evaluate advanced technologies
* Develop systems concepts
* Evaluate capabilities / cost / benefits

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMMODATION
P/L DEPLOY SYSTEMS & ADV. MANIPULATORS

TECHNOLOGY ISSUES:

* Planning and Control Algorithm Development
  - Path planning
  - Collision avoidance
  - Redundant manipulator control
* Sensor / Effector technology
  - Dexterous manipulators / force feedback systems
  - Robotic vision / tracking
* Interaction of deployment device with vehicle control
* System performance
* System reliability

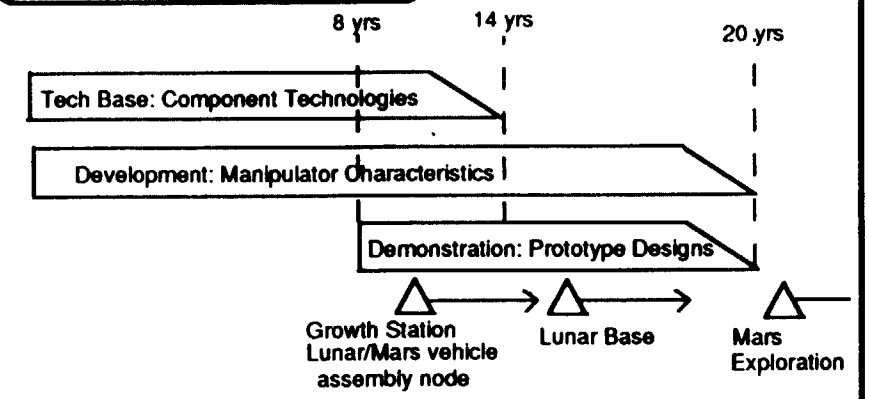
CANDIDATE PROGRAMS:

* Shuttle Remote Manipulator System
* Flight Telerobotic Servicer
* OMV
* Lunar Base
* Mars exploration
* EVA Retriever
* Special Purpose Dexterous Manipulator SPDM
* Mobile Servicing Centre

MAJOR ACCOMPLISHMENTS:

* Development of kinematic and dynamic simulators for generic remote manipulator systems and vehicle interaction
* Manipulator control law development and evaluation
* Telepresence systems technology investigations
  - Helmet mounted display
  - Stereoscopic vision systems
* Man-in-the-loop part task simulators
  - Shuttle Remote Manipulator System
  - Space Station Remote Manipulator System
  - Flight Telerobotic Servicer

SIGNIFICANT MILESTONES:



* Component technologies make up total manipulator system
* Robotic characteristics enhance manipulator operation and performance
* Prototype designs evolve over several generations

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMODATION
ADVANCED TELEMETRY SYSTEMS

NOVEMBER 1989

ADVANCED TECHNOLOGIES :

1. INTEGRATED DATA SYSTEMS
2. "INTELLIGENT " SYSTEM APPROACH
3. ADVANCED SIGNAL PROCESSING
4. PAYLOAD INTERFACE TECHNOLOGY
5. DATA DISTRIBUTION PROCESSING
6. INFORMATION COMPRESSION
7. VOICE AND DATA ENCRYPTION
8. MASS DATA STORAGE
9. ADVANCED MODULATION AND CODING.

MAJOR OBJECTIVES:

PROVIDE TRANSPARENT COMMUNICATION
SUPPORT SERVICES BETWEEN PAYLOAD AND ITS USERS
COMMON TELEMETRY STANDARDS
COMMON INTERFACES
LOW COST
HANDLE DIVERSE SERVICES
PACKET AND CIRCUIT SWITCHING
INTELLIGENT DATA BASE

KEY CONTACTS:

JSC/ K. LAND, H. VANG
LeRC/ J. BAGWELL, J. HARROLD
GSFC/ D. DALTON
NMSU/ F. CARDEN, S. HORAN
JPL/ N. HERMAN, C. ELACHI

KEY FACILITIES :

JSC- FLIGHT TELECOM DEV. LAB.
LeRC- DIGITAL SYSTEMS DEV. LAB
GSFC- LASER COM. LAB
NMSU- CENTER FOR SPACE TELEM. & TELECOM. SYSTEMS

MAJOR MILESTONES:

"COMMON' SIGNAL PROCESSOR

EVOLUTION OF STANDARDS
- ENCRYPTION (COMMERCIAL)
- TELEMETRY
- COMMON INTERFACES
- COMPRESSION
- HDTV

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMODATION
ADVANCED TELEMETRY SYSTEMS

NOVEMBER 1989

TECHNOLOGY ISSUES:

1. ENCRYPTION KEY MANAGEMENT
2. UNSUPERVISED RELIABILITY
3. Gbps DATA RATES APPLICATION
4. PROTOCOL/RATE SELECTION; LEVEL OF SERVICE RENDERED
5. INTELLIGENT MULTIPLEXING
6. ONBOARD VS. DISTRIBUTED PROCESSING
7. EFFICIENT LOSSLESS COMPRESSION

CANDIDATE PROGRAMS:

- STS UPGRADES
- SPACE STATION
- ADVANCED SHUTTLE
- LUNAR/MARS EXPLORATION

MAJOR ACCOMPLISHMENTS:

- EXPERTS SYSTEM APPLICATION IN DIAGNOSTIC/ MAINTENANCE SERVICES
- NEURAL NETWORK APPLICATIONS IN COMM. MODULE DESIGNS

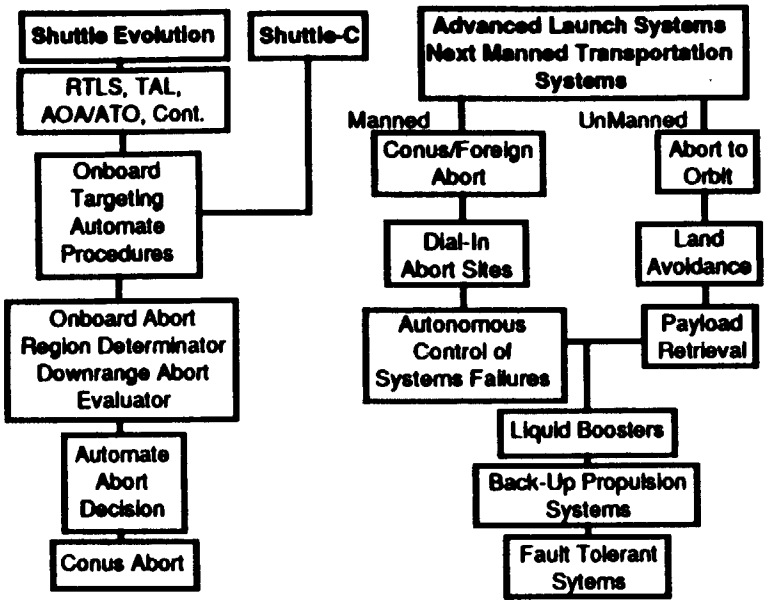
SIGNIFICANT MILESTONES:

- DEVELOPMENT OF STANDARDS FOR TRANSPARENCY
- CUSTOM SERVICES ON THE PAYLOAD ACCOMODATION TELEMETRY SYSTEM

SPACE TRANSPORTATION TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMODATIONS
ONBOARD ABORT PLANNING

NOVEMBER 1989

ADVANCED AVIONICS CONCEPTS



MAJOR OBJECTIVES

Provide Capability for:

- Single Failure Mission Completion
- Highest Probability of Vehicle, Payload and Crew Return
- Onboard Abort Decisions
- Fault Tolerant Systems
- Adaptive Control for Failures
- Onboard Targeting and Autonomous Guidance

KEY CONTACTS

- E. M. Henderson - JSC / DM
  - Richard Schmidgall
- A. J. Bordano - JSC / FM
  - McDonnell Douglas Space Systems Co.

Facilities:

- Flight Design Computational Facility - JSC / DM
  - Flight Analysis and Design System (FADS)
- MPAD Prototyping Lab - JSC / FM
- Shuttle Avionics Integration Lab (SAIL) - JSC / EA

MAJOR MILESTONES (1990-2005)

Technology Availability:

Onboard Expert Systems	1994
Adaptive Guidance Algorithms	1995
Advanced Sensors	1998
Flight Qualified Parallel Proc.	2000
Information Management System	2002
Advanced Onboard Man / Machine Interfaces	2002

SPACE TRANSPORTATION TECHNOLOGY SYMPOSIUM
PAYLOAD ACCOMODATIONS
ONBOARD ABORT PLANNING

NOVEMBER 1989

TECHNOLOGY ISSUES

- Liquid vs. Solid Boosters
- Automated vs. Manual Abort Techniques
- Ground vs. Onboard Abort Decision
- Development of High Density Mass Storage GPC's
- Onboard Parallel Processing for GN&C applications
- Development of Onboard Expert Systems
- Systems Enhancements to Sustain Multiple Engine Failures
  - Active CG Control
- Range Destruct vs. System Reliability

CANDIDATE PROGRAMS

- STS / STS Evolution / ASRM
- ELV'S
- STS - C
- ALS
- AMLS
- Lunar / Mars Initiative

MAJOR ACCOMPLISHMENTS

- Automation of Manual Procedures
- Onboard Abort Region Determinator / Downrange Abort Evaluator
- Dial-In Abort Sites
- Onboard Targeting and Abort Guidance
- Adaptive Guidance

SIGNIFICANT MILESTONES